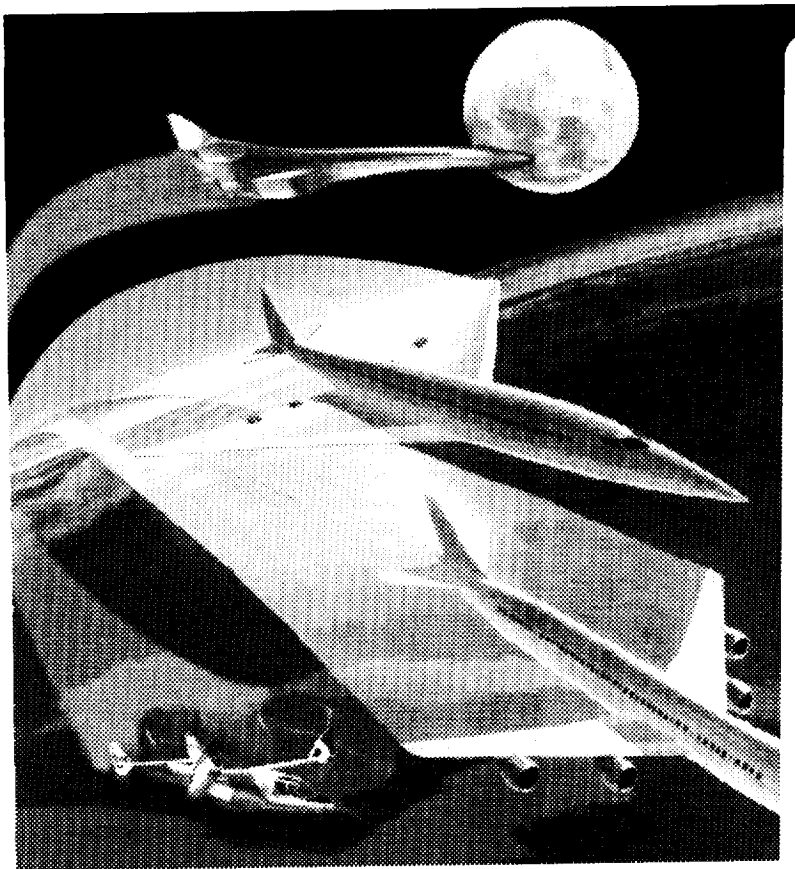


**Challenging the Future**  
***Journey to Excellence***

12590



**NASA**

**Lewis Research Center**  
Cleveland, Ohio

***Aeropropulsion Strategic  
Plan for the 1990's***

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(NASA-TM-109250) CHALLENGING THE  
FUTURE - JOURNEY TO EXCELLENCE.  
AEROPROPULSION STRATEGIC PLAN FOR  
THE 1990'S (NASA. Lewis Research  
Center) 27 p



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## INTRODUCTION

Over the past several months, the Lewis Aeropropulsion Management Council (AMC) has conducted a critical assessment of our strategic plan. This assessment coincided with (1) the development of the Center's new strategic plan, "Challenging the Future - Journey to Excellence," (2) an Agency-wide (Blue/Red Team) assessment of the aeronautics program, and (3) a Headquarters-commissioned survey of NASA aeronautics customers' satisfaction. The AMC also solicited and received valuable feedback from our Lewis aeropropulsion staff members on a variety of issues, including the Lewis culture, work environment, and management practices.

This assessment clearly indicated a need for change, both in our aeropropulsion program emphasis and in our approach to carrying out that program. Our customers sent a strong message that we must improve the timeliness of our research and technology products and services and encouraged us to work more closely with them to develop and transfer new technology. Internally, our staff has pointed to a number of operational processes and practices that need to be improved for us to be an outstanding, effective, high-performance organization. Our Aeropropulsion Strategic Plan for the 1990's represents our commitment to make the changes that we believe are necessary to achieve our vision and goals.

Our plan is strategic rather than tactical. It defines our vision for the future and our underlying organizational values. It contains a set of broad strategies and actions that point the way toward achieving our goals of **customer satisfaction, organizational effectiveness, and programmatic excellence**. Those strategies are expected to form the basis for the development of specific tactical plans by Lewis aeropropulsion thrust teams, divisions, and branches. To guide tactical planning of the aeropropulsion program, this strategic plan outlines (1) the Agency's strategic directions and long-range aeronautics goals, (2) the **aeropropulsion** goals and key objectives for achieving them, (3) projections of Lewis aeropropulsion budgets, (4) our planned allocations of resources, and (5) the processes that will be used to measure our success in carrying out our strategic plan.

We are fully committed to this plan. Join with us in making our vision a reality.

*The Aeropropulsion Management Council*

# THE LEWIS STRATEGIC PLAN

In formulating our plan, we have built upon the vision, principles of operation, and strategy presented in the Center's plan:

## Vision

Our vision of the future in aeropropulsion is derived from the Center's vision to be the **"best in the world"** in each of its four mission areas (aeropropulsion, space propulsion, space power, and space science and applications).

## Principles of Operation

We embrace and support all of the Center's principles of operation while emphasizing the importance of **our people, our customers, teamwork, and innovation.**

## Strategy

We adopt the major themes of the Center's strategic plan: **customer focus, continuous improvement, and improved technology transfer.** To implement those themes, we define strategies and actions that are consistent with the Center's commitment to **Total Quality.** Our plan is designed to carry out the Center's strategic objective/approaches for aeropropulsion. That is, we will

*"Sustain our premier role as NASA's Center of Excellence  
in aeropropulsion research and technology"*

by the following means:

- Meeting our programmatic commitments to NASA Headquarters, to other government agencies, and to our industrial partners
- Directing an increasing share of our vehicle-focused R&T efforts toward advanced aeropropulsion technology needs for both subsonic and supersonic transports
- Focusing more of our disciplinary R&T efforts on meeting the highest priority technology needs of the U.S. aeropropulsion industry and increasing our emphasis on multidisciplinary efforts
- Maintaining our solid partnership with the Department of Defense (DOD) laboratories in exploring new propulsion options for future military aircraft
- Continuing to plan and conduct collaborative aeronautics programs with the Ames and Langley Research Centers and improving collaboration with the related efforts of our partners in U.S. industry and academia

## **NASA'S AERONAUTICS THRUSTS**

Strategic and tactical planning of the Agency's aeronautics program is accomplished through an Integrated Planning Process (IPP) that involves Headquarters and the three NASA aeronautics research centers (Ames, Langley, and Lewis). Key managers from the three centers participate in a Headquarters-led "Aero Team" that sets overall policy, strategy, and goals for the program.

The Aero Team has organized the aeronautics program around the following six strategic thrusts:

- **Subsonic Aircraft/National Airspace**
- **High-Speed Air Transportation**
- **High-Performance Military Aircraft**
- **Hypersonic/Transatmospheric Vehicles**
- **Critical Disciplines**
- **National Facilities**

The first four thrusts address the development of key technologies for specific classes of aircraft. The latter two address the need for advances in our fundamental understanding of aeronautical systems and improved capabilities for design, analysis, and testing of new aeronautical systems. Goals to be achieved over the next 10 to 20 years are listed on the following pages.

Development of detailed, tactical plans for each thrust is accomplished by Headquarters-led inter-center teams that coordinate R&T activities at Ames, Langley, and Lewis. Since propulsion has characteristically been the pacing item in the aircraft development cycle, Lewis plays a key role in defining/ implementing the NASA aeronautics program. Our aeropropulsion program is focused on delivering critical propulsion technologies, services, and capabilities in a timely manner to achieve the Agency's goals. The Lewis aeropropulsion thrusts and key objectives are described in a later section of this plan.

## **NASA'S AERONAUTICS GOALS**

### ***By the year 2000, we will***

- Develop and validate key airframe, propulsion, and flight system technologies to meet industry's development windows for a new, **large** (500-800 passenger) **subsonic transport**, and a new generation of **superior small and medium size transports**
- Provide automation, flight management, and safety advances, both on the ground and in the air, to provide **increased capacity in the national air transportation system**
- Resolve the critical environmental issues of atmospheric emissions, airport noise, and sonic boom and establish the technology foundation for an economically viable **high-speed civil transport**
- Transfer flight-validated, thrust-vectoring control technology to DOD and industry to provide **military aircraft with unprecedented levels of maneuverability, agility, and survivability**
- Demonstrate use of **massively parallel computer architectures** to achieve much faster (1 trillion floating-point operations per second) computing for selected **multi-disciplinary aeronautical design and analysis** applications
- Complete wind-tunnel revitalization, ensuring **maximum reliability and productivity of key national facilities** and, in conjunction with DOD and industry, identify **critical needs and resource requirements for new facilities**
- Strengthen our partnerships with industry, academia, FAA, and DOD to ensure **maximum relevance and timely technology transfer**



## **NASA'S AERONAUTICS GOALS (concl'd)**

### ***By the year 2010, we will***

- Ready noise-reduction, all-weather-operation, and terminal-area-control technologies to support a market-responsive **tiltrotor commuter aircraft** for intercity travel
- Provide the FAA with selected ground and airborne technologies that will support an **automated, global airspace system**
- In cooperation with DOD, develop and flight-test technologies as cost-effective options for the next generation of **high-performance military aircraft**
- Demonstrate, through flight, the critical propulsion, materials, and airframe technologies for **airbreathing transatmospheric and hypersonic vehicles**
- Establish the technology base for, and demonstrate the use of, **high-performance computing, computer modeling, and numerical simulation** for cost-effective, multidisciplinary research, design, manufacturing, training, and certification of complete vehicle and propulsion systems

## **OUR VISION...**

***“To be the recognized leader in generating aeropropulsion technologies that support the global preeminence of the U.S. aeronautics industry”***

- **Our customers can depend on us to provide technological leadership and key technologies, facilities, and services.**
- **Our contributions ensure that our customers retain their technical superiority and economic competitiveness in the world market.**

## **...AND VALUES**

### ***Our People***

- **They are our most important asset and the key to our achieving excellence.**
- Their cultural diversity and varied experiences enrich our organization.
- They are motivated and excited by the challenge of their work.
- They maintain a sense of accountability for everything they undertake.

### ***Our Customers***

- **We constantly strive to understand and meet our customers' needs and expectations.**
- As a government agency, we consider our ultimate "customers" to be the U.S. taxpayers.
- In carrying out our mission, we focus on the end-users of our technology (i.e., the U.S. aeropropulsion industry, DOD, and FAA) as our principal customers.
- We collaborate with our customers to develop and transfer technology to achieve mutually beneficial objectives.

### ***Teamwork***

- **We achieve our goals through collaborative efforts that build on collective strengths.**
- The complexity and multidisciplinary nature of our work requires us to work together effectively.
- Teamwork fosters an appreciation for differing views, which leads to better solutions.
- Integrity, candor, and respect for all individuals are commonly held values essential to successful teamwork.

### ***Innovation***

- **We vigorously foster creativity and discovery.**
- Being on the leading-edge of aeropropulsion R&T, we must explore new and untried approaches.
- We are expected to take calculated risks to achieve high payoffs.

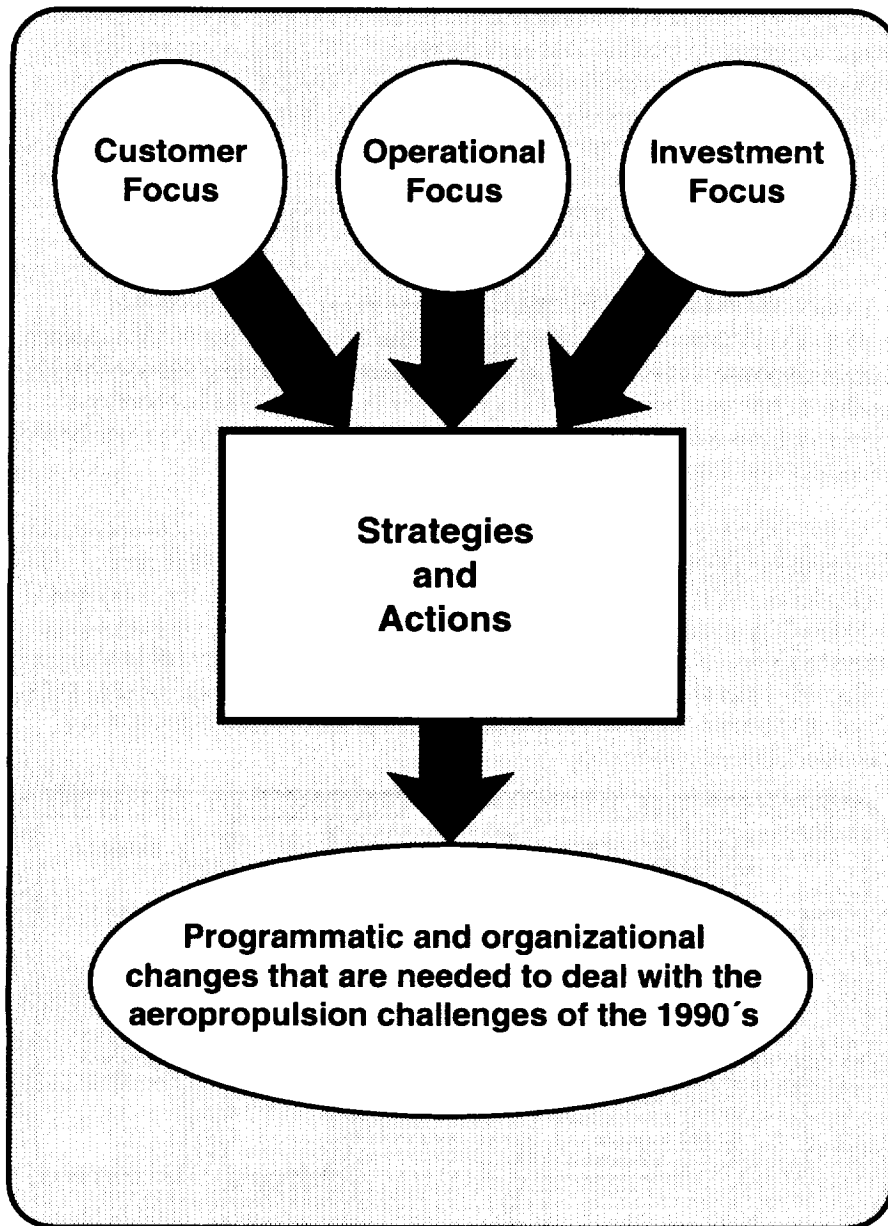
## **OUR AEROPROPULSION STRATEGY...**

In formulating our strategy and actions, we have addressed the major themes of the Center's strategic plan (Customer Focus, Continuous Improvement, and Improved Technology Transfer). We have focused our strategy in three areas that will support those themes and advance our aeropropulsion vision and goals. The three areas are **Customer Focus, Operational Focus, and Investment Focus**, and they are intended to accomplish the following strategic objectives:

- **CUSTOMER FOCUS**
  - Establish a strong focus on our customers, both internal and external, in everything we do; the goal is 100 percent customer satisfaction
- **OPERATIONAL FOCUS**
  - Ensure that we have an outstanding, effective, high-performance organization.
- **INVESTMENT FOCUS**
  - Define a high-level, resource-investment strategy that will continuously focus our R&T programs on achieving NASA's aeropropulsion goals while satisfying the highest priority needs of our customers

Our strategy and actions are outlined on the following pages. All of the strategies and actions will be implemented in accordance with the Center's commitment to Total Quality.

**...TO ACHIEVE OUR VISION**

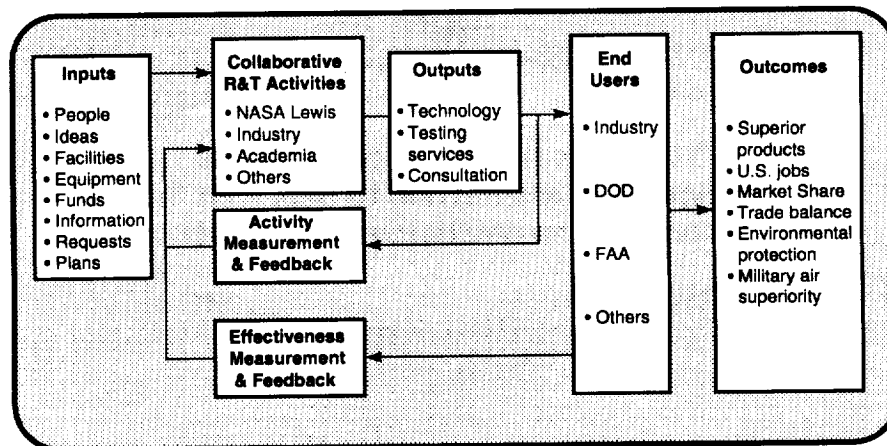


## OUR CUSTOMER FOCUS...

To ensure the maximum benefit to the U.S. taxpayers, we focus on the end-users of our technologies, facilities, and services as our "principal customers". These include the U.S. aer propulsion industry, the DOD, and the FAA. Sweeping political, economic, and social changes have occurred in recent years, including major cutbacks in military spending and an eroding U.S. share of the civil aviation market. These changes have increased the near-term pressures on our customers and are expected to increase their dependence on NASA for research and advanced technology.

To meet the challenges of the 1990's, we must increase our focus on our customers by (1) developing a deeper understanding of their needs, (2) increasing our involvement and collaboration with them, and (3) providing them with high-quality technologies and services in a more timely manner. We will back this customer focus with a world-class research program to ensure that we will be able to meet future requirements.

As the following figure illustrates, we must do everything we can to ensure that the "outputs" of our R&T program (e.g., technology, testing services, and consultation) will have the desired impact on the "outcomes" of our customers' activities (e.g., superior products, increased market share, positive trade balance, more U.S. jobs, etc.). We will work closely with our customers to define and carry out a well-focused aer propulsion program. We will negotiate agreements with them on expected "outputs" to establish a realistic basis for our pursuit of 100 percent customer satisfaction.



## **...SEEKS 100 PERCENT CUSTOMER SATISFACTION**

### **Strategies**

- Enhance and expand our knowledge of our principal customers' business needs
- Nurture a strong customer-focus attitude among our staff
- Improve technology transfer to meet the needs/expectations of all our principal customers

### **Actions**

- Gain better understanding of critical economic, political, technological, and competitive factors which impact our customers
- Establish mechanisms to improve Center/industry interactions
- Increase customer involvement in our program planning
- Ensure that our R&T efforts adequately address our customers' highest priority needs
- Recognize and reward exemplary "customer-focused" efforts
- Require periodic assessments by customers to gauge our achievements, timeliness, and impact
- Promote "technology transfer" as everyone's responsibility; plan for it and reward its accomplishment
- Increase the quantity and quality of our contracted/collaborative efforts
- Ensure that our program is beneficial to both large-engine and small-engine producers

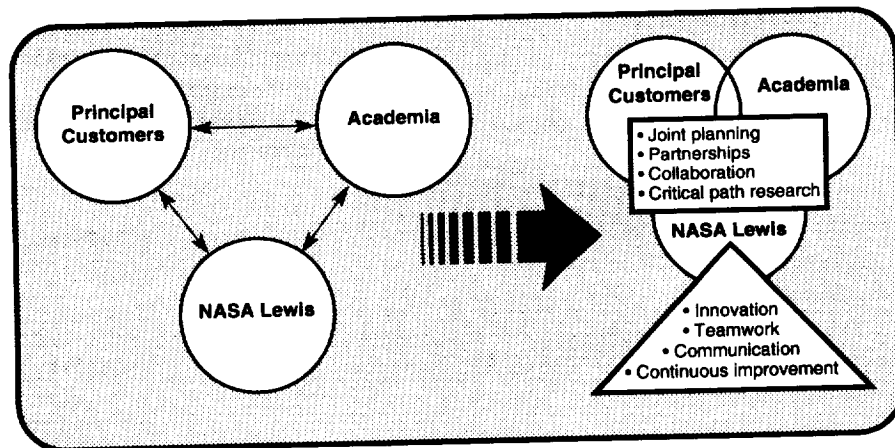
## OUR OPERATIONAL FOCUS...

Our operational focus is aimed at continuously improving both our internal and external operations to achieve excellence in our research and technology activities.

Internally, we seek to develop a culturally diverse, highly skilled, and motivated staff. We will establish a working environment for that staff that encourages and supports innovation, risk-taking, teamwork, open communication, and continuous improvement.

While undertaking these actions to improve our internal effectiveness, we will also work to build an organizational culture that thrives on interactions with our external customers. This will require a fundamental change in the way we conduct our R&T programs. In the past, we have tended to view our in-house R&T, industry contracts, and university research grants as separate, albeit related, activities. As a result, we often have failed to exploit the synergy of these activities that could have brought our combined resources and talents to bear on critical aer propulsion problems. In the coming decade, we will implement outreach strategies and actions to strengthen the collaboration between our in-house and outside R&T activities. We will work more closely with our principal customers and academia to jointly plan programs, form partnerships, and collaborate in critical-path research.

As part of our outreach strategy, we will work closely with educators to promote math, science, and engineering education and the development of future scientists and engineers who reflect the cultural diversity of our nation.





## **...WILL INCREASE OUR EFFECTIVENESS**

### **Strategies**

- **Foster a climate which promotes continuous improvement**
- **Ensure that all our organizations promote and maintain teamwork, innovation, and open communication**
- **Foster a creative environment that encourages staff development**
- **Strengthen our ties with our principal customers and academia**

### **Actions**

- Identify and remove barriers which inhibit continuous improvement
- Implement the principles of Total Quality (TQ)
- Develop a cross-cutting planning process that effectively integrates our R&T, facilities, and institutional suppliers
- Achieve excellence in our management practices
- Recognize and reward exemplary teamwork, innovation, and communication activities
- Develop a world-class staff that reflects the diversity of our nation's workforce and possesses the appropriate mix of critically needed skills
- Stress a "can-do" attitude, and encourage risk-taking and staff empowerment to achieve excellence
- Increase collaborative efforts, with emphasis on joint planning and collaboration on critical-path activities
- Promote math, science, and engineering education and foster the development of future scientists and engineers
- Encourage staff participation in community projects and events to build awareness of NASA's aeronautics programs

## OUR INVESTMENT FOCUS...

In formulating our investment focus, we have grouped strategic thrusts according to their primary user-base and function. This provides us with a higher-level basis for defining program emphasis and for making investment decisions. The three aeropropulsion investment groups are **Civil Applications, Government Applications, and Technical Foundation**. These are defined as follows:

- **Civil Applications** combines the Subsonic and Supersonic Transport thrusts. The end-users of this technology are the U.S. aeronautics industry, including the airlines, and the flying public. The key driver is **economic competitiveness**.
- **Government Applications** combines the High-Performance Military and Hypersonics thrusts. The end-user of this technology is the U.S. Government (e.g., DOD, NASA). The key driver is **affordable high-performance technology**.
- **Technical Foundation** combines the Critical Disciplines and National Facilities thrusts. These provide technology, facilities, and services to both internal (other thrusts) and external (the aerospace community) customers. The key drivers are **technology leadership and world-class institutional capability**.

Our investment strategy is consistent with the strategic priorities established by the Agency in response to the changing national needs in aeronautics. We will increase our investment in Civil Applications for both subsonic and supersonic transport propulsion. We will reduce our investment in Government Applications, focusing that investment on longer-term research and technology options. We will maintain the level of our investment in our Technical Foundation while taking steps to increase the synergy of our in-house, industry, and university R&T and to improve our technology transfer.

To support this strategy, we plan to increase our investment in external and collaborative programs. In FY 92, our investment in external programs accounted for 38 percent of our total R&D funding. By FY 96, we plan to achieve a 50-50 balance between our in-house and external endeavors. We will accomplish this through new initiative funding and exercising more "local" control of our institutional support costs as the Center moves to a more efficient, market-driven economy.

## **...WILL STRATEGICALLY ALIGN OUR RESOURCE INVESTMENTS**

### **Strategies**

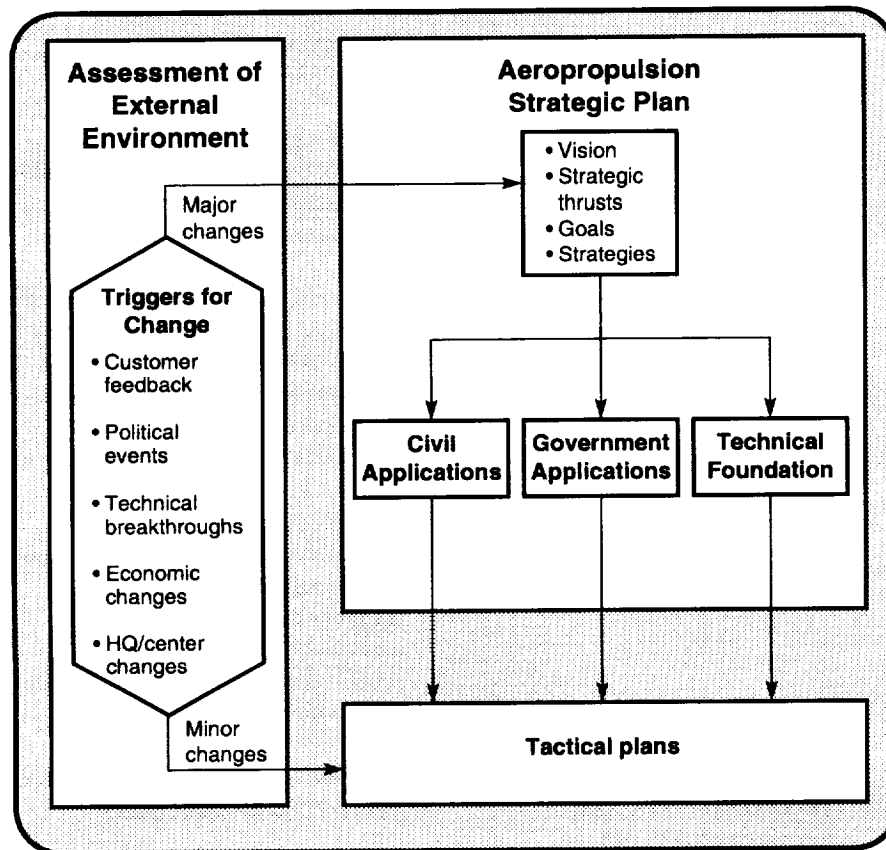
- Increase our investment in technology for Civil Applications
- Decrease our investment in technology for Government Applications
- Maintain current level of investment in our Technical Foundation
- Increase the synergy of our in-house, industry, and university R&T, and improve technology transfer

### **Actions**

- Increase our investment in supersonic transport propulsion through the High Speed Research (HSR) Program
- Increase our investment in subsonic transport propulsion, and focus these efforts on industry's highest priority needs
- Deemphasize high-performance military R&T while fostering research that will provide long-term technology options
- Establish an effective and affordable hypersonics research program as a long-term investment
- Enhance the quality and impact of our disciplinary R&T by fostering collaborative efforts that address selected, high-payoff needs of our principal customers
- Continue to emphasize and increase our level of effort in multidisciplinary R&T
- Establish an appropriately balanced investment in aeropropulsion facilities (experimental and computational) to ensure availability and effective utilization of premier capabilities
- Increase our investment in external and collaborative programs

## IMPLEMENTING AND ASSESSING OUR STRATEGY

Our strategic plan and high-level strategies are intended to be lasting. However, as the following figure illustrates, the internal (i.e., institutional) and external environments for aeronautics and aer propulsion are always changing and must be reassessed continually. This will be accomplished through interactions with our customers, advisory groups, NASA management, Lewis institutional suppliers, and our staff. Our strategies will be changed only in the face of major occurrences. Minor changes to the environment (e.g., technical, budgetary) are expected to result in more frequent adjustments to our tactical plans. The development of those tactical plans is the next step in our integrated planning process.



## **AEROPROPULSION THRUSTS AND KEY OBJECTIVES**

The Lewis aeropropulsion program is focused on delivering critical propulsion technologies, services, and capabilities to support the Agency's six aeronautics strategic thrusts:

- **Subsonic Aircraft/National Airspace**
- **High-Speed Air Transportation**
- **High-Performance Military Aircraft**
- **Hypersonic/Transatmospheric Vehicles**
- **Critical Disciplines**
- **National Facilities**

The following pages describe the key objectives of the Lewis aeropropulsion activities that support these thrusts. Tactical details for achieving the key objectives are contained in Lewis aeropropulsion thrust plans.

Note that a number of the thrusts include **interagency cooperative programs**. Under the Subsonic Aircraft/National Airspace thrust, Lewis is providing management and coordination of ceramic technology development for the DOE-funded Advanced Turbine Technology Applications Program (ATTAP) and Heavy-Duty Transport Technology (HDTT) program. In support of the High Performance Military Aircraft thrust, Lewis is carrying out a number of focused R&T activities related to the DOD-funded Integrated High Performance Turbine Engine Technology (IHPTET) program. Under the Hypersonics/Transatmospheric Vehicles thrust, Lewis is supporting the DOD-funded National Aerospace Plane (NASP) program.

Also note that the Subsonic Aircraft/National Airspace thrust includes two important **aircraft systems** technology efforts in Fly-By-Light/Power-By-Wire (FBL/PBW) and icing.

## ***AEROPROPULSION THRUSTS (cont'd)***

### ***Subsonic Aircraft/National Airspace***

#### **Large Transport Propulsion**

- Reduce high-bypass and ultrahigh-bypass engine and fan noise
- Reduce the nitrous oxide emissions of high-overall-pressure ratio engines
- Improve overall propulsion system efficiencies
  - higher turbomachinery efficiencies
  - higher-temperature materials and structures

#### **Civil Rotorcraft Propulsion**

- Develop critical technology options for advanced civil rotorcraft
  - advanced propulsion and power-train concepts
  - integrated propulsion-airframe controls

#### **Commuter/General Aviation Propulsion**

- Improve processes for fabricating and testing ceramic components and evaluating component reliability and durability (ATTAP/HDTT)
- Reduce engine and fan noise

#### **Aircraft Systems**

- Develop the technology base for confident application of integrated fly-by-light/power-by-wire systems in large civil transport aircraft
- Advance critical technologies to solve aircraft icing problems

### ***High-Speed Air Transportation***

#### **High Speed Research (HSR)**

- Develop and verify propulsion technologies essential for resolving the environmental issues of aircraft emissions and noise
  - combustors with ultralow emissions of nitrous oxide
  - low-noise nozzles
  - enabling propulsion materials
  - propulsion system concepts
- Develop and verify propulsion technologies essential for an economically viable, high-speed civil transport
  - propulsion system concepts
  - integration and validation testing of component technologies

## ***AEROPROPULSION THRUSTS (cont'd)***

### ***High-Speed Air Transportation (concl'd)***

#### **Supersonic Through-Flow Technology**

- Demonstrate viable performance levels for critical supersonic through-flow components
  - fan
  - core inlet/nozzle
- Demonstrate viable engine system performance, operability, and control across speed range for future supersonic cruise applications

### ***High-Performance Military Aircraft***

#### **Survivability**

- Develop critical propulsion technologies to enhance the survivability of future military aircraft

#### **High Alpha**

- Ready the high-payoff technologies to enable a doubling of high-alpha agility

#### **IHPTET**

- Develop technologies that will contribute to a doubling of propulsion system performance for a wide range of military aircraft

#### **Military Rotorcraft**

- Support the aeropropulsion needs of the Army's Propulsion Directorate (located at Lewis)

## ***AEROPROPULSION THRUSTS (cont'd)***

### ***Hypersonic/Transatmospheric Vehicles***

#### **National Aerospace Plane (NASP)**

- Develop selected technologies to support the development of propulsion systems for a single-stage-to-orbit hypersonic vehicle

#### **Hypersonic Research**

- Conduct research and develop the technology base to support development and testing of advanced, air-breathing, hypersonic propulsion systems
- Conduct system/mission studies of alternative propulsion concepts for transatmospheric and hypersonic cruise vehicles

### ***Critical Disciplines***

#### **Fluid Mechanics**

- Increase understanding of propulsion aero-thermodynamics, chemistry, heat transfer, and acoustics, and develop advanced computational methods to enable rapid design of improved components and systems

#### **Materials**

- Develop materials and processing technologies to reduce propulsion cost and weight and improve performance, safety, and reliability

#### **Structures**

- Develop structures, technologies, and life-prediction methodologies to improve propulsion development cycle, performance, safety, and reliability

#### **Instrumentation and Controls**

- Develop innovative technologies that provide needed measurements for aeropropulsion research and safe, reliable control of advanced propulsion systems

#### **Multidisciplinary Research**

- Develop multidisciplinary modeling and numerical simulation methods to exploit advances in high-performance computing systems to enable rapid design, analysis, optimization, and fabrication of new aeropropulsion concepts



## ***AEROPROPULSION THRUSTS (concl'd)***

### ***National Facilities***

#### **Capabilities**

- Ensure the availability of premier experimental and computational facilities for aeropropulsion R&T
  - Collaborate with industry to establish future requirements for facilities
  - Work with our Lewis institutional partners to develop and maintain a programmatically integrated, long-range, strategic plan for the facilities
  - Develop and test advanced facility concepts
  - Implement new facilities and modify existing facilities

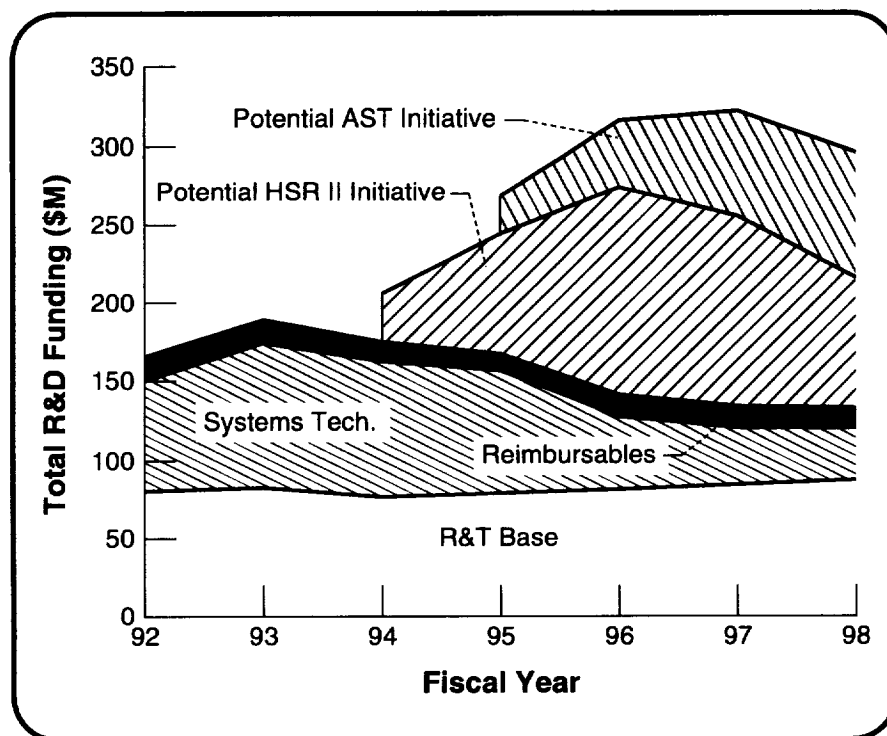
#### **Utilization**

- Ensure effective and productive utilization of premier experimental and computational facilities for aeropropulsion R&T
  - Provide efficient, world-class facilities to support R&T efforts in all strategic thrusts
  - Provide adequate maintenance to improve the reliability of the facilities
  - Provide safe, productive, and environmentally compatible facilities
  - Meet all test commitments to our customers

## RESOURCE PROJECTIONS

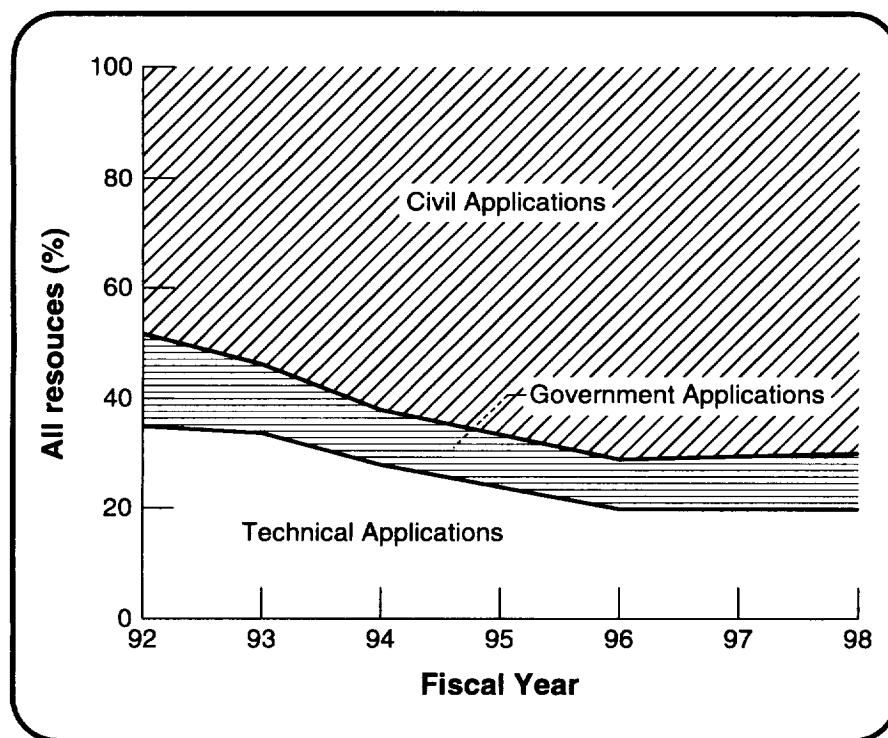
Below are shown projected total R&D (net R&D funding plus program support) budgets for FY 92-98. We will work with NASA Headquarters to plan and advocate potential new initiatives in areas such as High Speed Research Phase II (FY 94 start), and Advanced Subsonic Transports (FY 95 start). As appropriate, we will continue to work with other government agencies, such as DOD, DOE, and FAA, which provide funding to support synergistic research.

For FY 92-98, our civil service staffing level is expected to remain about constant, with our support service contractor staffing levels adjusted to meet our programmatic and organizational needs.



## PLANNED RESOURCE ALLOCATIONS

Below are shown the planned allocations of all aeropropulsion resources (total R&D funding plus dollar value of civil service workyears) for FY 92-98. In FY 92, resources were split about 48/17/35 percent between Civil Applications, Government Applications, and our Technical Foundation, respectively. Our investment strategy calls for an increased share of resources for Civil Applications, and reduced shares for Government Applications and our Technical Foundation. If the new initiatives in Civil Applications are approved, this investment strategy will, by FY 96, result in about a 70/10/20 percentage split of all resources between Civil Applications, Government Applications, and our Technical Foundation, respectively.



## **MEASURES OF SUCCESS...**

**The ultimate measure of the success of our Aeropropulsion strategies and actions is the impact of our program (technologies, facilities, and services) on the competitive status of our customers.**

However, because of the long lag time between technology development and its application, we must use interim methods, including surveys, to measure our progress. We will evaluate our efforts through periodic management assessments, day-to-day interactions with our customers, advisory-group and peer reviews of our programs, and specialized surveys of our customers, staff, and management.

Our **external** assessments will focus on:

- Congressional and administration support of our programs and budgets
- NASA-customer consensus on strategies and plans
- Our timeliness and technical progress relative to agreed-upon plans
- The quality, innovativeness, and relevance of our research
- The quality and impact of our collaborative activities and our customers' willingness to enter into follow-on collaborative activities
- Industry's confidence in, and dependence on, our in-house research and technology efforts
- The effectiveness of our technology transfer processes
- Utilization of our technology by our customers
- The availability and usefulness of our facilities to our external customers
- The impact of our contributions toward reducing engine development time and cost

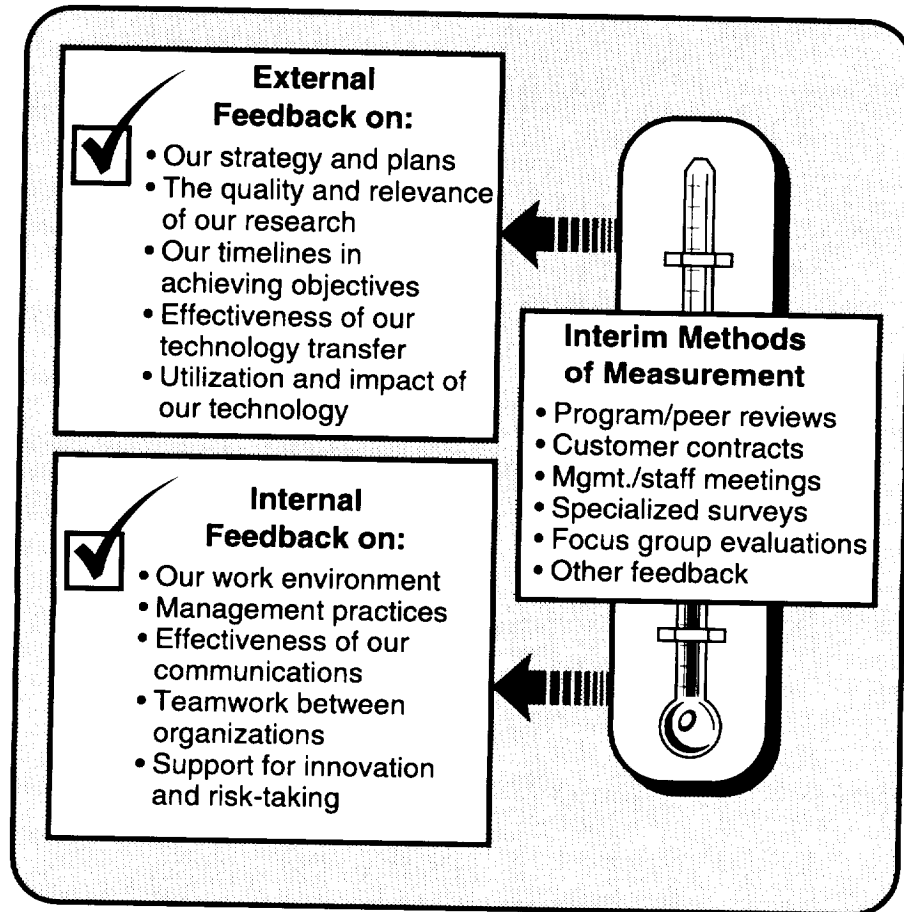
**Internally**, we will use management and staff surveys and focus group evaluations to measure our progress in improving our work environment, management practices, and organizational effectiveness. Particular attention will be given to assessing improvements in:

- Open and effective communication
- Teamwork between organizations
- Encouragement and support for innovation and risk-taking

## **...IN ACHIEVING OUR VISION**

### **Our Vision:**

*"To be the recognized leader in generating aer propulsion technologies that support the global preeminence of the U.S. aeronautics industry"*



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